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Effectiveness of a Structured Teaching Framework Compared to Traditional Approaches in Bedside Training of Gastrointestinal Surgery Nurses: A Randomized Controlled Trial

Mengnan Li
University of South China
Xi Chen
The First Affiliated Hospital of University of South China
Wenjuan Mo
University of South China
Qiaoling Chang
The First Affiliated Hospital of University of South China
Fenggang Liu
The First Affiliated Hospital of University of South China
Guang Fu
The First Affiliated Hospital of University of South China
Yuanyuan Yan
1442866843@qq.com

The First Affiliated Hospital of University of South China

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Abstract

Background

The transition from theoretical knowledge to clinical practice remains a significant challenge in nursing education, especially within high-acuity environments like gastrointestinal surgery. Traditional bedside teaching often lacks a consistent, structured approach. The BOPPPS model, a structured six-phase framework, offers a potential solution through its emphasis on interactive learning and iterative feedback.This study aimed to evaluate the effectiveness of the BOPPPS structured teaching framework, compared to traditional approaches, in enhancing clinical competence and self-directed learning ability among nursing interns during bedside training in gastrointestinal surgery.

Methods

In this randomized controlled trial, 91 nursing interns were allocated to either a BOPPPS-structured bedside teaching group (n = 47) or a traditional teaching group (n = 44). Clinical competence was assessed using the Mini-Clinical Evaluation Exercise (Mini-CEX), and self-directed learning ability was measured using a validated scale at 3 weeks post-intervention.

Results

The BOPPPS group demonstrated significantly higher Mini-CEX total scores compared to the control group ($p < 0.01$), with the difference exceeding the threshold for clinical significance. Significant improvements were also observed in key subdomains, including history-taking and physical examination. Self-directed learning ability, particularly in self-management, was also significantly enhanced in the intervention group ($p < 0.01$).

Conclusions

Implementing the BOPPPS model in gastrointestinal surgery bedside teaching significantly enhances nursing interns' clinical competence and self-directed learning. This study addresses a gap in educational methods for high-acuity nursing care and provides a validated, structured approach that can standardize and improve clinical teaching. The findings support the model's potential to contribute to better-prepared nursing graduates, which may ultimately improve patient care quality in complex surgical settings. Further multi-center studies are recommended to confirm generalizability.

Introduction

According to the World Health Organization, there are approximately 28 million nurses globally, representing 59% of the health workforce [1]. In China, approximately 300,000 new nurses enter the profession annually (NHC). Before beginning their careers, nurses must complete academic education and clinical training. Ongoing investment in nursing education is essential to prepare future professionals[2, 3] .

As a key reserve force in health care, nursing students' practical skills are a major focus [4].

Clinical education plays a vital role in the translation of knowledge into practice[5], helping students transition into professionals capable of addressing health care challenges[6] .

In gastrointestinal surgery nursing—which is characterized by diverse conditions, complex causes, and high-acuity patients[3] —bedside care is particularly challenging. Nurses must master wound management, ostomy care, drainage, complication recognition, pain assessment, nutritional support, and patient education (e.g., ERAS protocols). However, students in this rotation often face anxiety when they manage complex care, which reduces learning confidence and increases stress [7]. Limited hands-on opportunities due to safety concerns and clinical urgency further restrict skill practice [7]. This lack of practical engagement hinders theory-practice integration, decreases motivation and satisfaction, and may impair professional development [8].

Current bedside teaching methods for gastrointestinal surgery nursing include scenario-based learning, the online–simulation–bedside three-phase approach, and problem-based learning (PBL). While scenario-based training improves teamwork through small-group drills [9], it requires substantial time and resources, with simulated scenarios sometimes diverging from actual clinical needs [10]. The three-phase approach integrates technology in teaching [11]but faces challenges in gastrointestinal nursing because of its high cost, content disorganization, and unclear learning priorities. PBL promotes problem-solving skills[12]but depends heavily on students' prior knowledge and instructor input—which is often impractical in fast-paced gastrointestinal units where faculty availability is limited. These constraints can leave students' questions unresolved and reduce bedside applicability. Given the broad disease spectrum, high clinical acuity, and dynamic patient conditions in gastrointestinal nursing, existing methods have clear limitations, motivating our adoption of the BOPPPS model as a structured alternative.

Originally developed in 1979 by the Canadian Teacher Skills Workshop, the BOPPPS is an established instructional framework widely used in North America and is being increasingly adopted in China[13, 14]. Its six phases—bridge-in, objective, preassessment, participatory learning, postassessment, and summary—form a student-centered, systematic teaching process [15]. In bedside settings, BOPPPS helps contextualize learning using real patient cases, set clear goals, assess baseline understanding, facilitate hands-on participation, evaluate skill acquisition, and reinforce key points. Gastrointestinal nursing involves complex conditions and heavy clinical loads, requiring teaching models that balance educational structure and clinical efficiency. BOPPPS supports curriculum design, sequencing, implementation, and evaluation, fostering self-directed learning and critical thinking—which are essential in managing complex surgical patients[7, 16].

Although BOPPPS remains understudied in gastrointestinal nursing education, evidence in surgical settings is promising. For instance, BOPPPS combined with TBL improved exam performance, autonomous learning, and critical thinking among surgical nursing students [16]. Similarly, a BOPPPS-CBL hybrid model enhanced skill acquisition and satisfaction in trauma care training [17]and accelerated competency development among new nurses[18].

This study introduces the BOPPPS model into gastrointestinal surgery nursing bedside teaching. It aims to evaluate the model's ability to improve clinical competence and self-directed learning among nursing interns

while assessing its feasibility in gastrointestinal clinical environments. These findings may provide a theoretical basis for integrating BOPPPS into bedside teaching practices in this context.

Methods

Study aim

The purpose of this study was to compare the effectiveness of the BOPPPS structured teaching model and traditional teaching methods in improving clinical competence and self-directed learning skills among nursing interns in gastrointestinal surgery bedside training.

Study design

This study was a two-arm, parallel-group, randomized controlled trial (RCT) conducted to compare the effectiveness of the structured BOPPPS teaching framework against traditional bedside teaching methods. The trial was registered with the Chinese Clinical Trial Registry (No. ChiCTR2400083343).

Settings

The study was conducted in the gastrointestinal surgery department of a tertiary teaching hospital in China in 2024. The setting was a 45-bed ward primarily serving patients with malignancies, acute conditions, and hernias.

Participants

Participants were undergraduate nursing interns undertaking a compulsory clinical rotation in this department.

This study employed convenience sampling to recruit participants and strictly adhered to the following inclusion and exclusion criteria. **The inclusion criteria** were: □ undergraduate students currently undertaking internships at the affiliated teaching hospital who had successfully completed a four-year undergraduate nursing program and had commenced clinical practice; and □ individuals aged 18 years or older who provided informed consent indicating their willingness to participate in the study. **The exclusion criteria were**: □ nursing students who prematurely discontinued their internships or were unable to engage in the clinical assessment activities of the internship department; and □ nursing students who were unwilling to participate in the study or who withdrew from the study.

Prior to commencing their internship in the gastrointestinal surgery department, potential participants were recruited through an open call for volunteers by the research team. Recruitment materials detail the background of the teaching model, implementation plan, participation requirements, and informed consent process.

Sample size calculation

The sample size for this study was estimated a priori using G*Power 3.1.9.7. With parameters set at α = 0.05 (two-tailed) and statistical power (1-β) = 0.80 and a medium-to-large effect size (Cohen's d = 0.7) on the basis of previous meta-analytic findings in nursing and medical education[19, 20], the initial calculation under a 1:1 allocation ratio indicated a requirement of 34 participants per group. To account for a potential 20% attrition rate—a reasonable precaution given the longitudinal design and the demanding clinical environment, where participant availability could be affected by rotation schedules and clinical duties—the target sample size was conservatively increased to 42 participants per group, resulting in a total minimum sample of 84 participants.

Sampling techniques

Randomization procedure

This study employed a randomized individual allocation design. Upon enrollment, participants were immediately assigned to either the traditional teaching group or the BOPPPS group using a computer-generated random number sequence. Allocation concealment was ensured by placing the assignment information in sequentially numbered, opaque envelopes, which were opened only after each student had entered the department and baseline data had been collected.

To prevent contamination between groups within the shared internship environment (e.g., sharing of materials or discussions about teaching methods), several preventive measures were implemented. These included: staggering the teaching schedules of the two groups to avoid simultaneous contact; distributing all teaching materials via an encrypted platform to restrict cross-group access; and requiring all students to sign a confidentiality pledge.

Blinding strategy

Owing to the inherently visible nature of the pedagogical intervention (e.g., distinct teacher–student interactions and instructional activities), the blinding of participants and instructors was not feasible. Full blinding is a well-known methodological challenge in educational intervention trials, as the BOPPPS and traditional methods are fundamentally different and easily distinguishable for both the learners and the educators involved in delivery. However, to minimize detection and performance bias, robust measures were implemented: the assessors who conducted the Mini-CEX and scored the self-directed learning scales were blinded to group allocation throughout the study.

Furthermore, all outcome assessors received standardized training to ensure that consistent evaluation criteria were applied across all participants, irrespective of their group assignment.

Study participants and standardized protocol

The study participants included nursing interns who were undergoing clinical rotations in the gastrointestinal surgery department of a tertiary teaching hospital in China during 2024. The research was conducted in a ward equipped with 45 beds and staffed by 20 registered nurses, primarily serving patients with gastrointestinal malignancies (> 60%), acute conditions (e.g., appendicitis, obstruction; approximately 30%), and hernias. A total of 94 interns rotated through the department in temporally varied batches. Eligible interns within each

batch were randomly allocated to the experimental or control group (e.g., first batch: 5 experimental/5 control), and this procedure was consistently applied to all subsequent batches. However, 3 students withdrew for personal reasons after allocation but before completing the intervention, resulting in a final analytical sample of 91 participants (BOPPPS group: n = 47; traditional group: n = 44).Owing to the nature of the educational intervention (e.g., visible teacher–student interactions), complete blinding of participants and instructors was infeasible.

Both groups of students completed a 3-week internship in the gastrointestinal surgery department. The same teachers were responsible for theoretical, operational, and bedside teaching for both groups, and the curriculum and content were standardized in accordance with the teaching syllabus. This included one theoretical class per week (2 academic hours, 90 minutes) and one operational class per week (2 academic hours, 90 minutes). Each intern received one-on-one bedside teaching, with sessions typically lasting 10 to 20 minutes, and the teaching staff instructed the students at least twice a day. Upon entering the department, students from both groups were required to join designated WeChat groups. Group rules prohibited the dissemination of noninstructional content. The chief preceptor used the platform to distribute rotation schedules, instructional materials (e.g., didactic lecture notes, preview materials for the next day, teaching round content, procedural videos), and announcements. Students could pose discipline-related questions, and preceptors were required to respond within 24 hours. The main difference was that for bedside teaching, the experimental group followed the BOPPPS teaching model, whereas the control group received traditional teaching methods. The evaluation methods for both groups were consistent: students completed the Nursing Student Autonomous Learning Ability Assessment Tool to assess their self-directed learning ability both before and after their internship, and the Mini-Clinical Evaluation Exercise (Mini-CEX) was used to evaluate their bedside nursing skills before discharge (see attachments 1 and 2).

Interventions

The BOPPPS model

Setting up the BOPPPS teaching group

The structured teaching team comprised one head nurse overseeing operational coordination, one chief preceptor responsible for leading clinical curriculum design and quality control, and eight bedside nursing preceptors delivering hands-on clinical skill instruction. BOPPPS implementation commenced with Chief Preceptor Certification. The chief preceptor completed a 40-hour systematic BOPPPS training program covering all six core modules. Subsequently, the certified chief preceptor conducted cascade training for the bedside preceptors. This included theory workshops elucidating BOPPPS principles and microteaching drills using scenario-based simulations to translate knowledge into clinical teaching practice.

Team members are responsible for designing the teaching and evaluation methods prior to instruction. Bedside teaching staff are tasked with executing the bedside teaching plan, gathering student feedback, and refining the plan accordingly. The head nurse and chief preceptor oversee the implementation of the teaching plan and provide training for the teaching staff.

BOPPPS model implementation in the teaching process

Preclass preparation

All the students involved in the study joined the department's WeChat group. Before each formal teaching session, the chief instructor posts the teaching content in the group for students to review it in advance. The posted content includes the weekly practical teaching schedule, theoretical material to be reviewed before class, group discussions, group study tasks, nursing operation videos, and routine nursing procedures or emergency plans (see Table 1).

Table 1
Based on the prevention of venous thrombosis in BOPPPS teaching model

Teaching elements	Content of courses
Pre-teaching preparation	The ankle pump exercise video was sent to the students for self-study 3 days in advance.
Objective	Students can master the method of ankle pump movement and can guide the patient correctly.
Pre-Assessment	The teacher asks the students to demonstrate the operation of the ankle pump movement, judge whether the students master the operation, if the students have mastered it, then proceed to the next step; if the students have not mastered it, the teacher will correct the wrong action and demonstrate the correct action.
Participatory Learning	The students gave the ankle pump movement under the guidance of the teacher, and then lead the teacher to discuss other methods to prevent lower limb venous thrombosis with the students.
Post-assessment/Summary	The teacher makes comments on the students after completing the teaching activities, points out the shortcomings of the students, and urges the students to improve.

Bridge-in: Bridge-in: At the beginning of each bedside teaching session, the instructor spent 1–2 minutes on a brief Bridge-in to engage students and connect prior knowledge to the current case. This included posing a clinically relevant question, highlighting the learning objectives for the session, or briefly relating the case to previously encountered patients.

Objective

Teaching objectives for bedside sessions were typically limited to one or two, focusing on specific operational or clinical practice goals.

Preassessment

Prior to formal bedside teaching, teachers assessed students' preclass preparation through questioning. If the students'preparation was satisfactory, they proceeded to the participatory learning phase. If gaps were identified, the teacher provided clarification before proceeding.

Participatory learning

This phase constituted the core of bedside teaching, constituting the majority of the time. On the basis of the patient's condition, teachers guided students in performing nursing procedures or providing health guidance at the bedside. Timely feedback was provided during student practice. Discussions regarding nursing techniques and related approaches also occurred during this phase.

Postassessment

Postassessment included in-class checks and the final internship evaluation. At the end of the teaching activities, the teachers assessed understanding through questioning and practical exercises. During the final week of the rotation, the head nurse or chief instructor evaluated students' comprehensive bedside abilities using the Mini-CEX.

Summary

At the conclusion of each bedside teaching session, the instructor guided students in briefly reviewing and consolidating the learning content, reinforcing key knowledge points and essential skills. Simultaneously, the instructor provided overall feedback on students' performance during the participatory learning phase, highlighting strengths and areas for improvement. Additionally, both the instructor and students engaged in two-way feedback regarding the teaching process and offered suggestions to promote mutual improvement in teaching and learning.

Control group

The control group received identical course arrangements and instructional faculty as the experimental group, maintaining consistency in teachers, class duration, teaching frequency, one-on-one bedside teaching format, and curricular content. However, the instructors employed traditional teacher-led methodologies. All the students participated in the department's WeChat group, where the chief instructor disseminated teaching schedules, instructional videos, and self-directed learning materials systematically. During clinical practice, bedside teaching emphasized instructor demonstrations of nursing procedures, followed by student observation and simulated practice. Disease-focused coursework adopted lecture-based knowledge transmission through systematic explanations, requiring students to passively take notes and absorb content. The teaching rounds implemented case-based pedagogy beginning with instructor-guided patient selection, followed by faculty-led standardized case analysis, and concluded with student discussion and care plan summarization on the basis of their internship knowledge.

To ensure instructional quality, all the faculty members underwent rigorous certification. Theoretical instructors held valid university teaching credentials and received preinstructional quality evaluations from pedagogical experts. Bedside preceptors demonstrated validated clinical competencies before qualification. Nurse educators conducted comprehensive syllabus reviews and teaching content audits prior to program launch. A standardized preceptor manual was subsequently developed for unified implementation. All instructors completed centralized training modules and passed competency-based assessments (including lesson plan design critiques and simulated bedside teaching scenarios) before receiving the final teaching certification. This multilayered quality assurance framework ensured instructional consistency.

Data collection

Bedside Clinical Competency Assessment for Nursing Students: One week before the end of their departmental rotation, we will assess the bedside clinical competencies of the nursing students using the nursing-specific Mini-CEX tool. A dual assessment approach is employed, with both the chief instructor and bedside teachers evaluating the students' clinical abilities. The nursing-specific Mini-CEX tool covers seven key dimensions: medical history, physical examination, intervention/treatment management, counseling skills, nursing professionalism, organization/efficiency, and overall competence. Each core competency is rated on a 9-point scale, ranging from unsatisfactory (1–3) to satisfactory (4–6) to excellent (7–9). The internal consistency reliability of the scale is good, with a Cronbach's alpha coefficient of 0.7 (Motefakker et al., 2022). With respect to content validity, the scale was primarily assessed through two rounds of Delphi expert consultations on the final items, resulting in a high degree of satisfaction with the tool. Currently, the Mini-CEX demonstrates multifaceted application value in nursing education research, primarily by effectively enhancing students' clinical competencies (Khalafi et al. 2023), providing structured feedback (Batra et al. 2022), and exhibiting strong adaptability in interdisciplinary contexts (Alonso et al. 2024), among others.

Before and after the teaching intervention, the Autonomous Learning Competency Assessment Tool for Nursing Students (Lin and Jiang, 2004) was used to evaluate self-directed learning ability. This scale, widely used in research on nursing students' self-directed learning in China, comprises three dimensions, namely, self-management ability, information management ability, and learning/collaboration ability, totaling 28 items. Responses are recorded on a 5-point Likert scale ("completely agree" to "completely disagree"). The scores for positive items decrease, whereas the scores for negative items increase, yielding a total score range of 28 to 140. The internal consistency reliability of the scale is good (Cronbach's $\alpha = 0.86$). Content validity was primarily assessed through expert evaluation to ensure that the items adequately represented the intended constructs, resulting in high expert satisfaction following the two consultation rounds. Exploratory factor analysis was used to establish structural validity. This tool has been extensively implemented across China to evaluate nursing students' self-directed learning capabilities, frequently alongside professional competency scales in diverse educational contexts such as nursing education reform, online learning assessment, and interprofessional education programs (Hu B M et al., 2022).

Data analysis

Simultaneously, the student data are summarized, with references to page numbers from the original materials provided to facilitate easy retrieval and statistical analysis. Once each batch of practical teaching is completed and after the student materials have undergone double-entry and accuracy verification, the data manager prepares a database verification report. This report provides an overview of the study's completion status, checks the application of inclusion and exclusion criteria, verifies completeness, monitors adverse events, and includes other relevant details.

The data were analyzed using SPSS 26.0 (IBM Corp., Armonk, NY, USA). Analyses were independently performed by two researchers. The normality of continuous variables was assessed using the Kolmogorov–Smirnov (K-S) test and visual inspection of histograms. Normally distributed data are presented as the mean ± standard deviation (mean ± SD) and were compared using independent samples t tests. Nonnormally distributed data were analyzed using the Mann–Whitney U test and are presented as medians (interquartile ranges). Categorical variables (general characteristics) were compared between groups using Pearson's chi-

square test or Fisher's exact test, as appropriate. The significance level was set at $\alpha = 0.05$ for all the statistical tests.

Data completeness and quality assurance

All data entry was conducted using a double-entry process by research assistants working independently on separate computers using Excel. The resulting datasets were compared twice, and any discrepancies identified were reported to the project leader for resolution. All queries and responses were meticulously recorded using a query form and archived.

Ethical considerations

The study was approved by the Ethics Committee of the First Affiliated Hospital of the University of South China (No. 2024ll417001) and registered with the Chinese Clinical Trial Registry (No. ChiCTR2400083343, <https://www.chictr.org.cn/bin/project/edit?pid=227250%3E). Written informed consent was obtained from all the nursing student participants after the study's objectives and procedures were explained. Participants were assured of confidentiality. Specific confidentiality measures included the following:

1. Replacing all identifiers (e.g., names, student IDs) with encrypted codes during data collection;

(2) Processing bedside teaching videos using AI-based deidentification tools to blur faces and medical records;

(3) Specifying data anonymization methods and participants' rights to withdraw or request data destruction in the written consent form. Quarterly audits by the Ethics Committee confirmed adherence to these protocols.

Students had the right to refuse participation or withdraw from the study at any time without any negative consequences. Their participation was entirely voluntary and free from any form of pressure or coercion.

There are no conflicts of interest associated with this study. We have implemented measures to minimize any risks to the students, and in the event of any adverse effects during the teaching process, we address them promptly and take appropriate remedial actions.

Results

Between May and November 2024, 94 students from a teaching hospital in China participated in the teaching research. However, owing to personal reasons, three students discontinued their internships, resulting in a final cohort of 91 students included in the study. Of these, the control group included 44 participants (39 females and 5 males), while the experimental group included 47 participants (42 females and 5 males). No substantial differences were observed between the two groups in terms of general characteristics such as age, gender, or academic institution. (See Table 2.)

Table 2
Comparison of base-line data between the two groups of students

sex	IG	CG	X^2/t	p
	5/42	**5/39**	**0.000**	**1.000**
age	20.9 ± 0.8	20.6 ± 1.0	1.950	0.054
School				
School 1[a]	6/47	7/44	1.793	0.774
School 2[b]	18/47	20/44		
School 3[c]	16/47	10/44		
School 4[d]	5/47	4/44		
School 5[e]	2/47	3/44		
Independent learning ability scores				
self-management ability	35.5 ± 3.0	34.7 ± 4.9	0.870	0.387
information ability	34.4 ± 3.6	35.4 ± 3.1	-1.381	0.171
cooperative learning ability	23.7 ± 2.7	23.2 ± 2.2	1.003	0.319

a: Xiangnan University; b: University of South china; c: Chuanshan College University of South china; d:Shaoyang University; e: Hunan University of medicine

Clinical ability assessed at the bedside

Postintervention Mini-CEX assessments revealed statistically significant superiority of the BOPPPS group across all competencies. History-taking scores were higher in the BOPPPS group (5.8 ± 0.5 vs. 5.6 ± 0.5; $P < 0.05$). Greater differences were observed in the physical examination (5.1 ± 0.6 vs. 4.7 ± 0.6; $P < 0.01$). The BOPPPS group demonstrated substantially improved performance in terms of intervention/therapeutic skills (5.6 ± 0.5 vs. 5.2 ± 0.5; $P < 0.001$) and counseling skills (5.7 ± 0.5 vs. 5.3 ± 0.6; $P < 0.001$). Most notably, significant advantages were found for nursing professionalism (5.6 ± 0.5 vs. 5.0 ± 0.6; $P < 0.001$) and organization/efficiency (5.8 ± 0.4 vs. 5.3 ± 0.5; $P < 0.001$). This pattern resulted in a markedly higher overall score for the BOPPPS group (39.2 ± 2.3 vs. 36.2 ± 2.8; $P < 0.001$). All between-group comparisons were statistically significant (see Table 3).

Table 3
Mini-CEX scores after the experiment

History Taking	EG	CG	t	p
	5.8 ± 0.5	**5.6 ± 0.5**	**2.001**	**0.048**
Physical Examination	5.1 ± 0.6	4.7 ± 0.6	2.952	0.004
Intervention/Therapeutic Skills	5.6 ± 0.5	5.2 ± 0.5	3.711	<0.001
Counseling Skills	5.7 ± 0.5	5.3 ± 0.6	3.699	<0.001
Nursing Professionalism	5.6 ± 0.5	5.0 ± 0.6	4.626	<0.001
Organization/Efficiency	5.8 ± 0.4	5.3 ± 0.5	5.098	<0.001
Overall	39. 2 ± 2.3	36.2 ± 2.8	5.585	<0.001

Interpretation of the Magnitude of Difference

Compared with those in the control group, the Mini-CEX scores in the BOPPPS group were significantly greater. To evaluate the practical importance of this difference, we referenced the established benchmark for the Mini-CEX, which defines a 1-point difference as clinically significant[21]. The observed total score difference of 3.0 points substantially exceeds this threshold, confirming that the improvement is not only statistically significant but also educationally and clinically relevant, underscoring the substantial impact of the BOPPPS intervention.

Autonomous learning competencies

Comparison of autonomous learning ability between the two groups before the experiment

No statistically significant differences were observed between the two groups in terms of self-management ability (BOPPPS: 35.5 ± 3.0 vs. control: 34.7 ± 4.9; P = 0.387), information-handling ability (BOPPPS: 34.4 ± 3.6 vs. control: 35.4 ± 3.1; P = 0.171), or cooperative learning ability (BOPPPS: 23.7 ± 2.7 vs. control: 23.2 ± 2.2; P = 0.319) at baseline (see Table 2).

Comparison of autonomous learning ability between the two groups after the experiment

Following the intervention, statistically significant differences emerged. Compared with the control group, the BOPPPS group had higher scores for self-management ability (37.5 ± 2.8 vs. 35.1 ± 3.7; P < 0.005), information-handling ability (41.2 ± 2.5 vs. 38.4 ± 3.8; P < 0.001), and cooperative learning ability (25.6 ± 2.3 vs. 24.6 ± 2.5; P < 0.05) (see Table 4).

Table 4
Independent learning ability scores after the experiment

EG	The self-management ability	The information ability	The cooperative learning ability
	37.5 ± 2.8	**41.2 ± 2.5**	**25.6 ± 2.3**
CG	35.1 ± 3.7	38.4 ± 3.8	24.6 ± 2.5
t	3.501	4.232	2.125
p	0.001	<0.001	0.036

Discussion

Upon entering clinical practice after theoretical training, nursing students frequently encounter difficulties in integrating knowledge with clinical application, particularly in the complex environment of gastrointestinal surgery. The broad scope and often unstructured nature of clinical teaching in this area further hinders effective learning synthesis[22]. Our study demonstrated that the BOPPPS model significantly enhanced the clinical competence and self-directed learning ability of nursing interns during gastrointestinal surgery rotations. Importantly, optimizing education in this specialty aligns with critical health-system priorities: gastrointestinal surgeries are among the most common and high-risk procedures globally, with outcomes directly linked to surgical safety, patient recovery quality, and healthcare costs. Enhanced nursing competency in this field can reduce postoperative complications, shorten hospital stays, and lower readmission rates, thereby strengthening overall perioperative care efficiency and patient safety at the institutional and system levels.

From the perspective of pedagogical theory development, the BOPPPS model effectively addresses key challenges in clinical education by emphasizing student engagement and a closed-loop feedback mechanism. This design resonates with the constructivist learning theory's core concept of "active knowledge construction" and aligns with the emerging concept of "closed-loop management in clinical education". Research indicates that this structured teaching model not only enhances clinical practice abilities[7, 19]but its advantages in promoting knowledge acquisition, self-directed learning, and teaching satisfaction have also been widely validated in the field of nursing education[18, 20] .

Key implementation elements contributed to these outcomes: preclass preparation via social media platforms achieved full compliance, establishing an essential foundation[8], and high student engagement in clinical discussions supported participatory learning[23]. The preassessment phase proved crucial for identifying knowledge gaps before practice, while the frequently omitted summary phase suggests that in fast-paced surgical settings, real-time feedback during postassessment may be more valuable for learning consolidation [14].

The effectiveness of the model requires instructors to transition from traditional teaching to student-centered facilitation, demanding strong theoretical and clinical expertise to guide problem-solving effectively. As a flexible framework, the BOPPPS allows instructors to incorporate their expertise and adapt strategies

according to course content and student needs, ultimately optimizing learning outcomes while maintaining adaptability to clinical constraints.

This study confirms that the BOPPPS model demonstrates good feasibility and positive practical effects in clinical nursing education for gastrointestinal surgery. However, its mechanisms of action and applicable boundaries must be analyzed in depth within the specific context of clinical teaching.

Regarding the mechanisms of action, the BOPPPS model systematically addresses several core challenges in clinical teaching through its structured interactive cycle. Pre-class preparation and pre-assessment effectively activate students’prior theoretical knowledge, establishing cognitive anchors for clinical practice. This aligns with perspectives in situated cognition theory regarding the interaction between knowledge and context. In fast-paced clinical environments, the core interactive components—participatory learning and post-assessment—proved particularly effective, likely because they simulate the natural learning cycle of “observation-practice-feedback”inherent to clinical work, thereby facilitating the externalization of tacit knowledge and the consolidation of procedural knowledge. The improvement in students' self-directed learning ability observed in this study may also be partly attributed to the model's enhancement of students’self-regulatory efficacy through clear goals and immediate feedback.These pedagogical benefits translate into health-system gains by fostering a workforce that is better prepared to handle dynamic clinical situations, adapt to evidence-based updates, and engage in lifelong learning—all of which are crucial for sustaining quality and safety in surgical services.

However, the effectiveness of the model is highly dependent on the implementation context. Specifically, the role transformation and professional competence of instructors serve as key moderating variables. Shifting from traditional knowledge transmitters to learning facilitators and guides requires not only an update in teaching philosophy but also advanced abilities to quickly diagnose learning needs and scaffold understanding within complex clinical situations.

In summary, the BOPPPS model provides an effective framework for structured clinical teaching. However, its success is not simply due to the model itself but results from the dynamic alignment among the model’s core principles, instructor capabilities, and the clinical context. Future teaching practices and research should, while adopting the structural advantages of the model, place greater emphasis on developing instructors’contextualized pedagogical wisdom and strive to establish a comprehensive evaluation system that connects the assessment of the teaching process with terminal clinical outcomes. This will allow for a deeper understanding of the complete pathway through which educational interventions influence the development of nursing professionals.

Limitations

However, the present study has several limitations. The absence of long-term follow-up limits our understanding of the sustained effects of the BOPPPS teaching model. Without longitudinal observations over 3 to 12 months, we were unable to systematically assess students' competency retention rates, clinical decision-making transferability, or patient outcome indicators. Future research should establish long-term tracking mechanisms to evaluate these outcomes and confirm the durability of the intervention effects.

Conclusion

In conclusion, our study demonstrated that compared with traditional methods, the BOPPPS teaching model was more effective at enhancing clinical competence, self-directed learning, and information management skills among nursing interns. The model's structured, interactive framework successfully bridges theoretical knowledge and clinical practice. These findings provide robust evidence for adopting BOPPPS in comparable settings, thus warranting further validation and promotion across other nursing specialties, institutions, or student populations. Future research should employ multicenter, cluster-randomized designs with long-term follow-up to confirm the efficacy and scalability of this approach across diverse clinical learning environments.

Declarations

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Authors' Contributions

Mengnan Li and Yuanyuan Yan conceptualised the study.

Mengnan Li , Xi Chen, Wenjuan Mo, Qiaoling Chang and Fenggang Liu were directly involved in the clerkship teaching.

Xi Chen, Wenjuan Mo, Qiaoling Chang and Fenggang Liu were involved in the study’s design. Mengnan Li and Guang Fu were responsible for data collection and were involved in coding and data analysis.

Mengnan Li produced the first draft of the paper.

Yuanyuan Yan contributed to the iterative drafting and refinement of the manuscript.

All authors approved the final version of the manuscript for submission.

Ethics approval and consent to participate

This study was conducted in accordance with the latest version of the Declaration of Helsinki issued by the World Medical Association. The study was approved by the Ethics Committee of the First Affiliated Hospital of the University of South China (No. 2024ll417001) and registered with the Chinese Clinical Trial Registry (No. ChiCTR2400083343, <https://www.chictr.org.cn/bin/project/edit?pid=227250>), and all participants provided voluntary, informed written consent to participate.

Declarations of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

Consent for publication

Not Applicable.

Competing interests

Not Applicable.

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